Appl. No.: 10/698,723

Reply to Office Action of: 07/28/05



IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Appl. No.

10/698,723

Applicant

Ouyang, Michael

Filed

10/31/03

Title

OLED Structures with Strain Relief,

Antireflection and Barrier Layers

Art Unit

2879

Examiner

Hines, Anne M.

Docket No.

SP03-075

Commissioner for Patents

P.O. Box 1450

Alexandria, VA 22313-1450

CERTIFICATE OF MAILING (37 CFR 1.8a)

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William S. Frances Judith Riddell

DECLARATION UNDER 37 C.F.R. § 1.131

- 1. I, Michael X. Ouyang, am an inventor of the claimed subject matter of US Patent Application No. 10/698,723, Corning attorney docket no. SP03-075. I declare that I have first-hand knowledge of the facts set forth in this Declaration.
- 2. The invention claimed in the referenced patent application was conceived and reduced to practice in the USA.
- 3. I understand that willful false statements and the like contained herein are punishable by fine, imprisonment, or both, as provided by 18 U.S.C. § 1001, and may jeopardize the validity of the application or any patent issuing thereon.
- 4. The invention claimed in the referenced patent application was conceived on a date prior to March 29, 2002 and diligently reduced to practice as a laboratory model beginning at least as early as March 29, 2002. Conception is evidenced by the attached pages from my "Laboratory Notebook" and supporting description prepared after the actual reduction to practice of the invention claimed in the reference U.S. Patent Application. The attached document is a business document generated in the course of technological research and development as part of documenting inventions discovered in the regular course of business.

I declare that all statements made herein are based upon my own knowledge and to the best of my knowledge are true and all statements made on information and belief are believed to be true.

Michael X. Ouvang

Date

Date

DATE	
Flexible OLED Substrates with Sun-light legible and anti-scratching	
Background Page 1997	~
Sunlight legible is important for displays, especially handhold displays, such as cellular	
phones, digital and video cameras, automobile displays, where the display could be	
exposed to the very intense sun-light. The bright light could "wash off" the information	
displayed. To improve the contrast ratio of the display, dark background was proposed.	
Dark metal films for rear electrode were reported by Takeda [1]. These metal includes Mo,	
Zr, Ti, Y, Ta, Ni, Al with thickness of 1-300Å. Dobrowolski et al described "an optical	
nterference, electroluminescent device having low reflectance using multilayer	
metal/dielectric combination as the rear electrodes ^[2] . In these inventions, the low	
reflective components are the patterned electrodes.	
Flexible substrate is very attractive for the next generation flat panel displays, such as	
organic light emitting diods (OLED). The possible candidate for flexible substrates are	
polynorbornene (Tg:320 °C), polyimide (Tg:270-388 °C, DuPont's Kapton),	
polyethersulphone (Tg: 184-230 °C), polyethermide (Tg: 204-299 °C), polyarylate	
Tg:148-245 °C), polycarbonate (Tg: 150 °C), Transphan (Tg: 171 °C). However, OLED	
performmance is well known to be sensitive to humidity and oxygen. The above polymer	
substrates must be modified for OLED applications. The state of art packaging technique	
o enhance the barrier property of polymer substrates includes a) inorganic coatings on	
polymer substrate by PECVD ^[3] ; b)organic/inorganic laminar structure ⁴ ; c) Multifunction (filter, polarizing plate, phase difference plate, viewing angle control plate,	
LC alignment) laminated _hard pressing ^[5] ; d) Atomic mixing of F doped multilayer	
deposition of polymer composites by flash-evap and high energy radiation source	
electron, UV, IR, microwave, ultrasonic, or gama radiation) [6].	
election, ov, ix, inicrowave, uthasome, or gama radiation,	
norganic coatings has low yield strength, it could crack during the substrate bending. On	
the other hand, the hermetical properties of the coated polymer substrates depend on the	
coating thickness. But a thick dielectric coating will induce substrate curving due to the	*****
residual stress in the coatings. In this invention, we propose a coating structure for the	rater Pu
rear and front flexible substrates by using a combination of metal and hard inorganic	4 4 1 1 1 1 1
coatings. The New OLED substrate has a high yield strength, a low or high reflectivity	
depending on the application and an anti-scratching at the front surface.	*****

A tipical structure of OLED is described in figure 1 (http://www.uniax.com/), where the	
top and the bottom substrates can be glass or polymers. The front substrate (bottom)	الجد بيرا
must be transparent and the rear substrate does not need to be transparent. The cathode	
lines are low work function materials for electron injection, such as Ca, Li, Mg or their	± * *****
alloy Mg/Ag, Al/Li or multilayer LiF/Al, Li2O/Al, CsF/Al structures. The anode material	
must be transpaent for light pass through. ITO with high work function modified surface are required. In our invention, The surface of the front substrate will be coated with	
stress compensated multi-dielectric layers for antireflection, anti-scratch and humidity	

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RPOSE_									
	barrier co metal/diele shown in f	eatings and the ectric combination igure 2.	back side	le the the lark or mir	rear substrat ror humidity b	e will be arrier coating	coated w gs. Detail	rith ·	
	Nanocomp	oosite is a good hy	drophobi	c and anti-s	cratching layer.				e sontine de destruction et a
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		He	rmetic package	;					plant at any up a c
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			Poly	ymer layer					
			7//7	Glass substrate					
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	ī	O lines							
		Light emission							
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	Figure 1.	OLED device str	icture by	Olliax.					and the state of
		Interference dark co	ativa fac						
		hermetic seal of poly	ymer substrate	•					***********
			CONTRACTOR	Herm	rtic package				
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		110	F	AR contings of polymer s	for hemetic seal obstrate				
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	Figure 2	. Our invention	of modif	ied flexible	substrates wi	th good wate	er and ox	ygen	
		barrier properti	es and a A	AR nad high	contrast prope	rties.			
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c	OLED substate DATE.	
=	Technical Description	
	Dark coatings for rear substrate	
	The structure of humidity and oxygen barrier layer i	s shown in figure 3.
	D: Transparent layer (100	0-300 nm)
	F: Hydrophobic layer (10nm-100 μm) C: Absorbin	g layer (1-100 nm)
	E: Mirror metal 50-200 mm	B: Polymer substrate (50-10000µm)
	T. B. B. A.	A: Index matching layer (1-300 nm)
	Figure 3. Coating structure on a rear polymer substr	ate of a OLED
	The dark coatings can be constructed by metal/diele structure. The theory is based on the well known int light intensity will be canceled if the reflected lig interfaces/surface has a added equal intensity but oppout of phase).	erference phenomena that the ht from difference thin film
-	The absobing layer C can be a thin dark metal coating Inconnel, etc,) or thin absorbing dielectric (diemond deficient In ₂ O ₃ , ITO, SnO ₂ etc) or a semiconducto GaN, Se, GaSe, GaTe, CdTe, TiC, TiN, ZnS, ZnO, C	d-like Carbon, SiOx, oxygen r coating (Si, Se, Ge, GaAs,
•	The transparent layer can be dielectric layer with of (Al ₂ O ₃ , AlON, BaF ₂ , BaTiO ₃ , BeO, MgO, GdO ₃ , Sc ₂ O ₃ , SiO ₂ , Si ₃ N ₄ , TiO ₂ , Y ₃ A ₁₅ O ₁₂ , Y ₂ O ₃ , ZeSiO ₄ , Bi ₁₂ SiO ₂₀ , etc)	Nb ₂ O ₅ , ThO ₂ , CeO ₂ , HfO ₂ ,
	Coating C and D are the basic repeating structure humidity barrier effect. The thickness of layer E m stack. Coating A and/or F may or may not necessar and the materials performance.	ay be different from stack to
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PURPOSE		
	The minute metal can be Al. An. An. Dr. or dialoctric mirrors	and the state of t
	The mirror metal can be Al, Au, Ag, Pt, or dielectric mirrors.	constitution of the section between the section and the section of
	The charge meeting are he demonstrad < 100 °C has a beam on his anattaging or has	yanga in samanya mara kara ka in dalah kati Mistari da
	The above materials can be deposited <100 °C by e-beam or by sputtering or by	a object managele saladi saara a persona salas salah a ta bi 1 ora 1 di sa
-1·•	web coating techniques.	contraction of the second section is a second secon
-		and the second second second second
	Figure 4- figure 5 is the simulation of reflectivity of light from multilayers	
••	through polymer (Topas® (n=1.53))/or glass (n=1.52-1.53) substrate.	
•		
•	ticks insident forms	
•	Light incident from: Glass/NY(7nm)/SIO2(71.5nm)/Al(80 am)	
	Reflectance (%)	Autoria de la compansión de la compansió
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	Wavelength (nm)	
	Figure 4 Reflection of three layer structure where light is reflected from Topas®	Transcript actarre
	or glass/W(7nm)/SiO ₂ (71.5nm)/Al(80 nm)	a . dr. am 1.1 g . d . dr. am 1989
		in the designation of the design
	Light incident from:	g year to the production and construction and
	Glass/W(6.1nm)/SiO2(78.5nm)/W(15.3nm/SiO2(78.5)/AJ(71 nm)	
	Reflectance (%)	
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···	Wavelength (nm)	manager and addressed a contract of the desired of the second of the sec
		to again and a second control and accommission of
	Figure 5 Reflection of three layer structure where light is reflected from Topas®	sand of the experience of the state of
·····	or glass/W(6.1nm)/SiO ₂ (78.5nm)/W(15.3nm/SiO ₂ (78.5)/Al(71 nm).	and the second second
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		ay has no anti-gla			munon or dank sauc	Julio,	
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							Application and a service designations.
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	<u>k</u> n						
	(b) A1/	150nm) electrode	. ==	/(20nm)/Al(100nm			
	(D) A1(130mm electrode	S OII (C) W	((201111//A)(10011111	i) electiodes		
	-						
	Figure 6.	(a) Dark multir	laver on gl	ass. (b)Al electrode	e on glass, and (c) t	olack	
	_	electrode on gla			, on Brass, and (a)	,	
		3					
							
		Structure (b)	On (a)	Structure (C) or	n (a)		***************************************
			() - 1 - 1	() () () ()			
	Figure 7.	structure (b) on	(a) and stru	cture (c) on (a) of i	ngure 3	* ***	
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PURPOSE				المناف المناورة الموااد الما
green with the exercise of the				.,
	*** 1: oima etress compens	etion technic	que to minimize the stress of film stack	
	A A A A A A A A A A A A A A A A A A A	, aantral the	process such as spillicinity prosure,	
	1 - itis meta and the time of	`material '''`	We can achieve zero total aucos.	and the second of the second
	Another way to prevent the DC	lymer from	warping is to coat inorganic materials	
· v arter ve	on both sides of the polymer su	hstrate to ba	lance the stress.	,
man the most				
	We claim a hydrophobic mate	rials as the o	outer layer to cover the whole opotical	•• ····· · · · · · · · · · · · · · · ·
المعادية والمواقع	and among horrier. The hydro	mhohic laver	can be polymer layer, such as 1 11 b,	
Applying the Nation of		annulfana ac	s well as nano-composite clays such as	rage way a said the site
	leman layered cilicate nanoci	omnosites. "	I hese serious of fiand materials can	
	greatly enhance the moisture t	parrier prope	rty as well as the hardness for surface	Control of the State of the Sta
or a to the see the	anti-scratching.	,	•	
	diti-solutions.			
1 m 1 m 1 m 1 m 1 m 1 m 1 m 1 m 1 m 1 m	AR coating on front substrate			
			11 13th hamier lever	
J. 100 0	One to four inorganic layers ca	an be used as	the oxygen and humidity barrier layer.	
	T: 0 -1 a thean lover ar	stiretlection S	emichire. The hymophobic layer should	
	have a refractive index less t	han 1.45. tra	insparent morgame layers with the or	
	three different refractive index	es are require	ed for multilayer AR design.	
gaz, 20 a 5 f - 7	E: Index matching	laver for ITO) (10nm-100 μm)	
a time on the special states	•			
	A: Polymer su	ıbstrate (50-1	.0000µm)	
	\ \ R: Tr	ronenarent las	yer n ₁ (10-300 nm)	
Control of the Contro	\ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \		rent layer n ₂ (10-300 nm)	
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and the transfer of the transf	J 17-7	D: F	Hydrophobic layer (10nm-100 μm)	
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a de montas consultas companios de cons	Figure 8 A typical three lave	r AR design	where the outer layer could be a	
grafia (Implementaria de 1919) de la composição de 1919 de 191	hydrophobic materi	als with low	refractive index.	
and the second s	Hydropitoote			
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		The refractive index of one layer AR coating should be close to n _{substrate} 1/2. ITO has a	and the first control of the second of the s
	-]	refractive index of about 2.0 at 550 nm. The index matching layer E should have a n ≈ 1.81. Si ₃ N ₄ , SiON, BiO2, etc are the best choice.	
	7	Aultilaren AD agating ala 1 AD 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	
	C	Multilayer AR coating give a broad AR band as well as a better barrier effect. The choice of each layer depending on the refractive index and thickness. For a three layer AR	mende com de tax de faite l'écol a
	C	oating, Angus Macleod discribed that the condition for the vectors to be equal length but opposite directionshould be ^[11] :	and the second s
			con the state of the second
		$y_1/y_0=y_2/y_1=y_3/y_2=y_{sub}/y_3$	te i en deum estembje San i teramina estembje
	v	Where y ₁ (i=0,1,2,3,) is the optical admittance of the ith layer. 0 is referred to the air.	, a respective mental engage
	Ť	Therefore, if $n_{\text{substrate}} = 1.52$, the four layer AR coating can be air/MgF(n=1.38, 92.7	
	n	m)/ZrO2(n=2.06, 131.7 nm)/MgF(30.3nm)/ ZrO2(16.5 nm).	* . * . *
		,	
	О	Other high/low (refractive index) combination using the transparent dielectric films as	
	d	escribed in previous section is also possible.	
		, and seemed and position	** * * * * ***************************
	n	ano-composite clays can also be used for the first layer for water barrier as scratch	70 - 01117 1100 00±0917000
	re	esistant coating.	e,
			a la companie
	<u>R</u>	<u>eferences</u>	
	ı	N. T. I. A. I. VIO. D. C. A. D. D. D. C. D.	
		M. Takeda et al: US Patent: 4,287,449, 1981	
•	2	EP 0372763A2	
	3	WO 01/82389 A1	g is go as a fee feeger was
	4	EP 0977469A2, WO 00/36665	any fortuna sundays. Any tradesium day a \$400
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